

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1.-4. (canceled)

5. (currently amended) The gas concentration detecting apparatus according to claim 420, wherein the feedback amplifying circuit ~~has is configured to have~~ a function of limiting an output ~~of the feedback amplifying circuit thereof~~ into a predetermined range.

6.-9. (canceled)

10. (currently amended) The gas concentration detecting apparatus according to claim 921, wherein

the determination unit includes a unit ~~configured to determine~~that determines that the actually operated amount is abnormal, provided that the actually operated amount is lower than a predetermined threshold; and

the processing unit includes a unit ~~configured to change~~that changes the actually operated amount to the predetermined value in cases where the determination unit determines that the actually operated amount is abnormal.

11. (currently amended) The gas concentration detecting apparatus according to claim 10, comprising a unit ~~that determines~~configured to determine that there occurs abnormality

relating to short circuit in the terminals of the sensor element, when the abnormality relating to controlling the sensor is detected and ~~when~~ the actually operated amount is abnormal.

12. (currently amended) The gas concentration detecting apparatus according to claim 921, wherein

the control unit ~~is provided with~~ comprises a feedback amplifying circuit connected to the positive terminal and the negative terminal of the sensor element, the voltage being applied to the sensor element via the feedback amplifying circuit,

the measurement unit ~~is configured to measure~~ that measures either the current value or the voltage value in response to the change caused in either the applied voltage or the element current at a position on an output side of the feedback amplifying circuit,

wherein the feedback amplifying circuit ~~is configured to have~~ has a function of limiting an output ~~thereof~~ of the feedback amplifying circuit into a predetermined range.

13.-18. (canceled)

19. (new) A gas concentration detecting apparatus applied to a gas concentration sensor including a sensor element sensing a concentration of a gas to be detected, the sensor element being equipped with a solid electrolyte member and one or more pairs of electrodes disposed on the solid electrolyte member, the apparatus comprising:

a control unit configured to control a voltage applied to at least one of positive and negative terminals connected to the electrodes of the sensor element;

a measurement unit configured to measure either an element current flow caused by the

applied voltage corresponding to a concentration of a specific component of the gas, every time the voltage is applied under the control of the applied voltage, or an electromotive force generated between the electrodes of the sensor element corresponding to the concentration of the specific component of the gas, every time the voltage is applied under the control of the applied voltage;

a change causing unit configured to cause a change in either the applied voltage to the sensor element or the element current through the sensor element;

a change amount measuring unit configured to measure an amount of a change in each of a current value and a voltage value caused in response to the change caused in either the applied voltage or the element current;

a calculation unit configured to calculate an amount of a resistance component to resist the element current flow through the sensor element on the basis of a ratio between the amounts of the changes in the current value and the voltage value; and

a detection unit configured to detect abnormality relating to controlling the sensor by utilizing information relating to the amount of the resistance component calculated by the calculation unit, the information being at least one of the amounts of the changes in the current value and the voltage value,

wherein the detection unit comprises

a monitor unit configured to monitor the measured amount of the change in either the current value or the voltage value; and

a determination unit configured to determine occurrence of the abnormality on the basis of the amount of the change monitored by the monitor unit, when the amount of the change in either the current value or the voltage value is equal to zero or a value substantially regarded as

zero.

20. (new) A gas concentration detecting apparatus applied to a gas concentration sensor including a sensor element sensing a concentration of a gas to be detected, the sensor element being equipped with a solid electrolyte member and one or more pairs of electrodes disposed on the solid electrolyte member, the apparatus comprising:

a control unit configured to control a voltage applied to at least one of positive and negative terminals connected to the electrodes of the sensor element;

a measurement unit configured to measure either an element current flow caused by the applied voltage corresponding to a concentration of a specific component of the gas, every time the voltage is applied under the control of the applied voltage, or an electromotive force generated between the electrodes of the sensor element corresponding to the concentration of the specific component of the gas, every time the voltage is applied under the control of the applied voltage;

a change causing unit configured to cause a change in either the applied voltage to the sensor element or the element current through the sensor element;

a change amount measuring unit configured to measure an amount of a change in each of a current value and a voltage value caused in response to the change caused in either the applied voltage or the element current;

a calculation unit configured to calculate an amount of a resistance component to resist the element current flow through the sensor element on the basis of a ratio between the amounts of the changes in the current value and the voltage value; and

a detection unit configured to detect abnormality relating to controlling the sensor by

utilizing information relating to the amount of the resistance component calculated by the calculation unit, the information being at least one of the amounts of the changes in the current value and the voltage value;

wherein

the detection unit is provided with a monitor unit configured to monitor the amount of the change in either the current value or the voltage value, the amount of the change being measured by the measurement unit, and a determination unit configured to determine the abnormality on the basis of the amount of the change monitored by the monitor unit;

the control unit is provided with a feedback amplifying circuit connected to the positive terminal and the negative terminal of the sensor element, the voltage being applied to the sensor element via the feedback amplifying circuit;

the measurement unit is configured to measure either the current value or the voltage value in response to the change caused in either the applied voltage or the element current at a position on an output side of the feedback amplifying circuit; and

the determination unit is configured to determine that there occurs the abnormality, when either the current value or the voltage value measured at the position on the output side of the feedback amplifying circuit is fixed at a boundary value or thereabouts of a range in which the feedback amplifying circuit operates.

21. (new) A gas concentration detecting apparatus applied to a gas concentration sensor including a sensor element sensing a concentration of a gas to be detected, the sensor element being equipped with a solid electrolyte member and one or more pairs of electrodes disposed on the solid electrolyte member, the apparatus comprising:

a control unit configured to control a voltage applied to at least one of positive and negative terminals connected to the electrodes of the sensor element;

a measurement unit configured to measure either an element current flow caused by the applied voltage corresponding to a concentration of a specific component of the gas, every time the voltage is applied under the control of the applied voltage, or an electromotive force generated between the electrodes of the sensor element corresponding to the concentration of the specific component of the gas, every time the voltage is applied under the control of the applied voltage;

a change causing unit configured to cause a change in either the applied voltage to the sensor element or the element current through the sensor element;

a change amount measuring unit configured to measure an amount of a change in each of a current value and a voltage value caused in response to the change caused in either the applied voltage or the element current;

a calculation unit configured to calculate an amount of a resistance component to resist the element current flow through the sensor element on the basis of a ratio between the amounts of the changes in the current value and the voltage value; and

a detection unit configured to detect abnormality relating to control of the sensor by utilizing information relating to the amount of the resistance component calculated by the calculation unit;

wherein

the change amount measuring unit includes an operated amount measuring unit configured to measure an actually operated amount of either the applied voltage or the sensor current when the change is caused in the either the applied voltage or the sensor current and

the detection unit includes

a determination unit configured to determine whether or not the actually operated amount is abnormal; and

a processing unit configured to change the actually operated amount to a predetermined value, to calculate an amount of the resistance component by using the predetermined value of the actually operate amount, and to detect abnormality relating to controlling the sensor based on the amount of the resistance component resulting from the predetermined value of the actually operate amount.

22. (new) A gas concentration detecting apparatus applied to a gas concentration sensor including a sensor element sensing a concentration of a gas to be detected, the sensor element being equipped with a solid electrolyte member and one or more pairs of electrodes disposed on the solid electrolyte member, the apparatus comprising:

a control unit configured to control a voltage applied to at least one of positive and negative terminals connected to the electrodes of the sensor element:

a measurement unit configured to measure either an element current flow caused by the applied voltage corresponding to a concentration of a specific component of the gas, every time the voltage is applied under the control of the applied voltage, or an electromotive force generated between the electrodes of the sensor element corresponding to the concentration of the specific component of the gas, every time the voltage is applied under the control of the applied voltage;

a change causing unit configured to cause a change in either the applied voltage to the sensor element or the element current through the sensor element;

a change amount measuring unit configured to measure an amount of a change in each of a current value and a voltage value caused in response to the change caused in either the applied voltage or the element current;

a calculation unit configured to calculate an amount of a resistance component to resist the element current flow through the sensor element on the basis of a ratio between the amounts of the changes in the current value and the voltage value; and

a detection unit configured to detect abnormality relating to control of the sensor by utilizing information relating to the amount of the resistance component calculated by the calculation unit,

wherein

the change amount measuring unit includes an operated amount measuring unit that measures an actually operated amount of either the applied voltage or the sensor current obtained when the change is caused in the either the applied voltage or the sensor current, the actually operated amount serving as the information relating to calculating the amount of the resistance component and serving as the amount of the change in one of the current value and the voltage value; and

the detection unit includes a determination unit that determines that there occurs the abnormality, when the actually operated amount is zero or a value substantially regarded as being zero.

23. (new) A gas concentration detecting apparatus applied to a gas concentration sensor including a sensor element sensing a concentration of a gas to be detected, the sensor element being equipped with a solid electrolyte member and one or more pairs of electrodes disposed on

the solid electrolyte member, the apparatus comprising:

a control unit configured to control a voltage applied to at least one of positive and negative terminals connected to the electrodes of the sensor element;

a measurement unit configured to measure either an element current flow caused by the applied voltage corresponding to a concentration of a specific component of the gas, every time the voltage is applied under the control of the applied voltage, or an electromotive force generated between the electrodes of the sensor element corresponding to the concentration of the specific component of the gas, every time the voltage is applied under the control of the applied voltage;

a change causing unit configured to cause a change in either the applied voltage to the sensor element or the element current through the sensor element;

a change amount measuring unit configured to measure an amount of a change in each of a current value and a voltage value caused in response to the change caused in either the applied voltage or the element current;

a calculation unit configured to calculate an amount of a resistance component to resist the element current flow through the sensor element on the basis of a ratio between the amounts of the changes in the current value and the voltage value; and

a detection unit configured to detect abnormality relating to control of the sensor by utilizing information relating to the amount of the resistance component calculated by the calculation unit;

wherein

the change amount measuring unit includes an operated amount measuring unit that measures an actually operated amount of either the applied voltage or the sensor current obtained

when the change is caused in either the applied voltage or the sensor current, the actually operated amount serving as the information relating to calculation of the amount of the resistance component and serving as the amount of the change in one of the current value and the voltage value;

the detection unit detects the abnormality with reference to the actually operated amount;

the control unit includes a feedback amplifying circuit connected to the positive terminal and the negative terminal of the sensor element, the voltage being applied to the sensor element via the feedback amplifying circuit;

the measurement unit measures either the current value or the voltage value in response to the change caused in either the applied voltage or the element current at a position on an output side of the feedback amplifying circuit; and

the determination unit determines that there occurs the abnormality, when either the current value or the voltage value measured at the position on the output side of the feedback amplifying circuit is fixed at a boundary value or thereabouts of a range in which the feedback amplifying circuit operates.